CONSIDERATIONS ON REHABILITATION OF IRRIGATION SPRINKLER PLOTS AND OF THE PUMPING STATIONS

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Abstract

The paper presents an analysis of the guidelines for the rehabilitation of irrigation plots to sprinkler watering. Irrigation systems from Romania were conducted in 40 to 50 years, and most are degraded at the present stage. Part of irrigation sprinkler plots is in operation, but the important phenomena of wear and aging. Their rehabilitation is carried out on the two major components, pressure pumping station and (PSP) and the network of pipelines. Rehabilitation and modernisation of the PSP is achieved differentiated on structural and functional components: constructive structure, technological hydromechanics line, protection installation from accidental pressure variation, electrical supply installation, installation of monitoring and automation parameters. Case studies drawn on several SPP from Moldova reveal the complexities of rehabilitation and modernization. This should be the successive stages and by using modern materials and technology execution.

Key words: rehabilitation, irrigation sprinkler plot, pumping station, hydromechanics installations

Irrigation systems in Romania were made 40-50 years ago, in the art and materials existing at the time. Much of the irrigation systems were dismantled after 1990 and only a few are still in operation. Irrigation systems in operation (generally the sprinkler for watering) show degradation processes constructive and functional system.

At the current stage are used most small irrigation systems (irrigation plot) with sprinkler watering. Most of them were made in the years 1967-1985 and they were components of major irrigation systems. A number of irrigation systems were equipped for watering mixed (surface irrigation + sprinkler watering. At the current stage is practiced mainly sprinkler watering. Irrigation plot was designed in two pump units equipped with: a - plot equipped with a "pressure pumping station" (codified PPS); b - plot equipped with "single line pumping station" (pumping station supplying water of the single distribution pipe for irrigation SLPS). In the first variant, PPS supplies a network of buried pipes for high pressure sized (7.0 - 8.0 bars). In the second version, pumping stations are located on the inlet channel and fuel distribution pipe one high pressure (6.5 ... 8.0 bars).

Irrigation systems made in both versions wings distribute the water through the sprinkler. The first version of equipment below presents a case that can apply both types of irrigation (sprinkler + flow furrows). This variant can now two pipelines: the first is for sprinkler network (pressure 8-9 bar); the second pipeline is to wet the flow furrows (low pressure, 4.0 bar).

Rehabilitation and modernization of SPP is done differentiated structural and functional components: building structure, hydromechanical technological line, installation of protection from accidental pressure variation, energy supply system, plant monitoring and process automation operation. Case studies drawn on several PPS from Moldova reveal the complexities of rehabilitation and modernization. This should be the successive stages and by using modern materials and technology execution.

MATERIAL AND METHOD

The case studies were prepared for sprinkler irrigation systems located in Iasi, Vaslui, Braila and Insula Mare of Braila. For each irrigation system was developed technical expertise to determine the structural and functional status. Technical expertise has analyzed the current state of the constructive structure of the pumping station operational after a period of 35-40 years.

Technical expertise has analyzed the current state of structural and functional technological lines of the pumping station. Functional state of the

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technological line analysis of hydro energy balance is achieved by pumping aggregates. Energy balance is drawn up based on measurements made pumping station for various operating situations. The main parameters considered in the analysis (Luca M., 2000; Exharhu M., 1997)

- energy used for pumping

(1) $$E = P_a \cdot T \ ,$$

(2) $$E = \frac{2{,}725 \cdot k \cdot V \cdot H}{\eta_a}$$

where E is energy , kWh; V - the volume of water pumped thousand m^3; H - to the head, m ; η_a - yield pumping aggregates ; P_a - aggregate installed capacity pumping; T - pumping time; k - coefficient which takes into account energy consumption in auxiliary facilities;

- the specific energy consumption for transport under load H unit volume pumped:

(3) $$e = \frac{2{,}725H}{\eta_a} \cdot \left(\frac{kWh}{1000m^3 \cdot m} \right)$$

- unit specific energy consumption per unit volume of water under a load H = 1.0 m:

(4) $$e = \frac{2{,}725}{\eta_a} \cdot \left(\frac{kWh}{1000m^3 \cdot m} \right)$$

- randamentul agregatului de pompare:
- yield pumping aggregates:

(5) $$\eta_a = \eta_T \cdot \eta_m \cdot \eta_p \cdot \eta_h \ ,$$

η_a where is the total yield; η_T - yield of electrical transmission; η_m - electric motor yield; η_p - pump yield; η_h - hydraulic yield.

Relationships (3, 4 and 5) are applicable only if the pumps are identical.

Equipment for the pumping station with old and new proposed parameters will determine the operating point (Q_F, H_F, n, D) (Burchiu V. *et al*, 1981; Luca M., 2000).

RESULTS AND DISCUSSIONS

The research was conducted on plots irrigation pumping stations equipped with pressurization (PPS) of the pipeline. Most irrigation plots with SPP were performed in the years 1970 -1985, according to type projects (Project 4824R - 1984). Pumping stations were carried out only type SPP infrastructure, which consists of mud box, chamber grids and wet suction hopper. Building structure is made of reinforced concrete. On the cover plate of the tank is placed pumping aggregates and hydraulic pumps. On board chamber grids and mud box mounted installation grilles facility for water filtration.

Irrigation plots have areas of 800 ... 2000 ha. The plot of applied irrigation watering mixed type (sprinkler + flow furrows), or only sprinklers. Pressurizing stations (PPS) were fitted with diagonal vertical pump type VDF (type later removed), MV and MA. Providing pumps designed to ensure operating parameters for the two methods of watering.

PPS1b station pressurizing of the irrigation system Soloneţ-North is a classic presentation *(figure 1)*. Irrigation plot serves an area of 1428 ha. Pressurizing station was designed in 1980, made in 1980-1983 and commissioned in 1983. The pumping station was designed with two pressure stages, to serve two methods of watering *(figure 1)*:

- sprinkler watering served by step I was pumping (parameters: flow Q = 0.800 m^3/s and pressure P = 8.50 bars);
- flow furrows served by the second stage of pumping (parameters: Q = 0.200 m^3/s and pressure P = 4.50 bars).

Aggregates pumping parameters are shown in *Table 1*.

Table 1

Technical data pumping aggregates PPS1b mounted

Vertical pump MV 253 x 4	Vertical pump MA 200 x 5
Q = 0.140 m^3/s	Q = 0.064 m^3/s
P = 8.50 bars	P = 4.50 bars
n = 1500 rot/min	n = 1500 rot/min
N = 200 kW	N = 55 kW
U = 380/660 V	U = 380/660 V
η = 60%	η = 55%

a b

Figure 1 **The hydromechanics line to old SPP1b: a - front view; b - side view, highlighting the two pressure stages**.

a

b

Figure 2 **Details on the status of the pumping station SPP1b components: a - taps and check valves on the discharge line; b - hydrophor installation**.

From the analysis results in the following (Luca M., 2012):

- hydro mechanical technology line of stage I and stage II after 35 years of operation presents an advanced physical wear; This condition causes a sharp decline in yield parameters (hydraulic pumping operation) and an increase in costs per m^3 of water pumped;

- type MV and MA pumps are worn and outdated as technical level after 35 years of operation; MV and MA pumps is no longer manufactured and are not spare parts; pumping unit energy consumption of large east because of low yields;

- hydraulic installation of the pumping station is worn, outdated operating periods (valves, dampers) and outdated; pipes are worn out and causes loss of water with high pressure pumping *(figure 2 a)*;

- drive electric motors that are worn and outdated technical level after being used for 35 years; yield electric motors is low and exhibits frequent damages;

- hydraulic installation of shock protection system is fully degraded *(figure 2 b)*;

- monitoring installation of the operational parameters is partially degraded;

- pumping station does not have an automation system.

Simulation parameters functioning of the pumping station pumps operating after 35 years an increase in energy consumption by about 28 ... 37 % from baseline at start-up (Luca M., 2012).

In conclusion, that should be performed rehabilitation and refurbishment of the pressurizing pumping station to increase efficiency and decrease energy consumption in operation. Directions rehabilitation of the pumping station is:

1. Rehabilitation works constructive structure of PPS by restoring integrity wet tank and mud box. Resizing and achieve concrete plate supporting new pumping aggregates, according to their weight and the hydraulic system.

2. Replacement of pumping aggregates with modern pumps and high efficiency. Engines will present a variable speed drive to reduce energy consumption in pumping engines (frequency converter).

3. Replacing the hydraulic pumping station (pipes, valves, check valves, fittings, etc.). The valves will allow for automation processes in the pumping station.

4. Rehabilitation of the plant protection hydraulic shocks the structural and functional components. The installations of the pumping station adapting to process automation.

5. Rehabilitation energy supply system components and structural adjustment process automation. Power demanded by new pumping aggregates should fit value existing electrical transformer station.

Figure 2 **Details on the status of the monitoring instalation**

All sequences rehabilitation process must be carried out fully to achieve the correct operation of the pumping station. SPP1b pumping station was rehabilitated in compliance with the above requirements. In the first stage construction was rehabilitated suction chamber, mud box and access area. In the second stage were selected pumping aggregates and were mounted on a reinforced concrete resized. In the third stage they were rehabilitated other facilities serving pumping station.

PPS 1b Solonet–North station was equipped with variable speed pumps. Pumping station was commissioned in 2016 *(figure 3)*.

From studies on how to rehabilitate irrigation plots in Moldavia revealed a series of problems:

- lack of rehabilitation of reinforced concrete structure of the tank and mud box; without verifying the resistance of the plate tank and resize it;
- equipping pumping station with pumps we do not calculate the point of pumping parameters (flow, pressure, power and yield);
- no hydraulic installation rehabilitation of the pumping station;
- no rehabilitation facility hydraulic shock protection installation of the pumping stations and to some it was disbanded;
- lack of automation installation of pumping station operation.

a b

Figure 4 **The pumping station SPP1b rehabilitated: a - general view; b – hydraulic installation.**

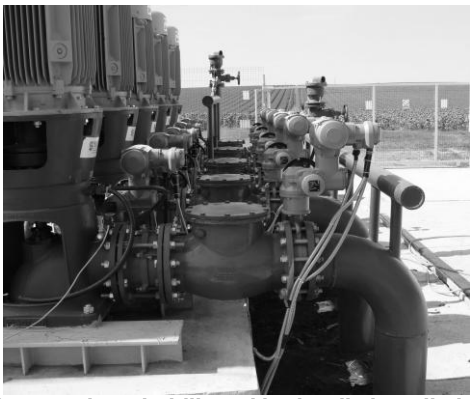

Figure 5 **The rehabilitated hydraulic installation of the pumping station SPP1b**

Pumping stations serving only rehabilitated and analyzed sprinkler watering.

CONCLUSIONS

Irrigation plots are the most common components of the old rehabilitated irrigation systems made in Moldavia.

Rehabilitation of pumping for pressurizing is performed on all building structures and facilities components to achieve low power consumption and decreasing water loss.

Rehabilitation of pumping stations type SPP had to be made to the prior art complex with the introduction of monitoring and automation of mining.

A series of restoration projects lately type SPP pumping stations were not conducted in a complex way, a situation that causes a malfunction with high energy consumption and the water loss in the system.

REFERENCES

Burchiu V., Santău I., Alexandrescu O., 1981 - *Pumping plants (in Romanian),* Edit. Did. şi Pedag., Bucureşti.

Cunha, M.D., Sousa, J., 1999 - *Water distribution network design optimization: simulated annealing approach*, Journal of Water Resources Planning and Management, ASCE, 125(4), 215

Exharhu M., 1997 - *Asupra aprecierii performanţelor energetice ale instalaţiilor de pompare*, Hidrotehnica, vol. 42, nr. 2.

Exharhu M., 1997 - *Asupra randamentelor instalaţiilor de pompare*, Hidrotehnica, vol. 42, nr.

Luca M., 2012 - Expertiza tehnică a Staţiei de pompare SPP 1b din obiectivul de investiţii „Modernizarea si retehnologizarea staţiilor de pompare pentru irigaţii a Aqua Soloneţ Nord Bivolari, judeţul Iaşi. S.C Polias – Instal S.R.L. Iaşi.

Luca M., 2000 - *Optimizarea consumului energetic prin reabilitarea hidraulică a instalaţiilor de pompare*, Simpozionul " Ştiinţa modernă şi energia", Cluj - Napoca.

Luca M., 2002 - *Consideraţii privind folosirea pompelor cu turaţie variabilă în staţiile de pompare*, Conf. “Instalaţii pentru construcţii şi confortul ambiental”, Timişoara.

*** **Proiect nr. 4824-R 1987** - *Proiecte tip de construcţii pentru Îmbunătăţiri Funciare Catalog 4, subcapitolul Staţii de Pompare de Punere sub Presiune pentru Irigaţii*, ISPIF, Bucureşti.